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New Orleans--City surveyor

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Report on drainage...

# REPORT ON DRAINAGE,

TO THE

# CITY COUNCIL OF NEW ORLEANS.

BY

B. M. HARROD,

CITY SURVEYOR,

NOVEMBER 22, 1888.

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*To the Mayor and Council of the City of New Orleans:*

GENTLEMEN—In obedience to your resolution of November 13th I have the honor to submit this report on the drainage of the City.

The greater part of the City of New Orleans is built on the alluvial slope of the east bank of the Mississippi river. This slope, extending from the river to Lake Pontchartrain, has a width of from four to seven miles. The total inclination is about fifteen feet, from the river towards the lake; but it is so much more rapid nearest the river that it is exhausted in the first two miles, leaving a level and swampy plain adjacent to the lake, from two to five miles wide, and with about the elevation of high tide.

The uniformity of this topography is broken by the Metairie and Gentilly ridges, running generally parallel to Lake Pontchartrain, about two or three miles from its shore. They have sufficient height to restrain the incursions of storm tides and prevent the drainage of the area occupied by the City directly back to the lake.

The natural drainage of the slope upon which the City stands was, therefore, along the valley or depression between the high alluvial bank of the river and the ridges just described, to the eastward, until about half a mile below Canal street it divided between two routes The larger part thence discharged through Bayou St. John directly into Lake Pontchartrain, while the balance followed down the depression between the river and ridge, and sought an outlet through Bayou Bienvenue to Mississippi Sound.

The original and only function of Bayou St. John was the drainage of the site of the present city and the lands in its rear. The Supreme Court declared that it was not a naturally navigable stream. Yet the strange result has occurred that, while a private corporation has acquired the right to improve its navigation, the City has lost its original and normal servitude on the only natural use the stream possessed, that of drainage.

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The development and extension of this natural system should have formed the basis of all the drainage work of the City. Unfortunately, the favorable features here presented were not recognized or sufficiently appreciated at the time. The navigation canals, however important as arteries of commerce, were so located as to interfere seriously with the natural drainage of the City, and to add to the original difficulties of discharging large volumes of water over long lines and light gradients, artificial, and apparently permanent obstructions. The drainage of the City would be now much simplified if the basins and upper parts of the navigation canals were as far back as Broad, or even Galvez or Claiborne streets, thus allowing the location of the main line of discharge along the lowest levels of the area to be drained.

It is practicable to use conduits under the navigation canals, but such a resort would be costly, as well as objectionable and unsatisfactory in other respects.

It is therefore necessary that any plan of improvement should accept and deal with the conditions imposed by these canals.

An essential feature of a complete system of drainage and improvement is its fitness for gradual but progressive application. While making use, as far as possible, as what has already been done, it should adequately meet, as fast as money is provided, the most urgent present dangers and deficiencies, and then, without change of system, or abandonment of previous details, admit of the ultimate development demanded by any increase of area, wealth, cleanliness or public spirit. Hence, while such a plan will contain much work that is not immediately demanded or practicable, it is not worthy of consideration if it does not clearly and scientifically provide for logical extension from the works of immediate and simple necessity to a modern and complete development of City sanitation and improvement.

The leading features of such plan, adhering as far as is convenient to the order of their importance, or in which it would be found expedient to execute them, may be thus enumerated:

1st. A survey, to ascertain the exact relative levels of the area to be drained, the proportion of drainage to rainfall, and the character and capacity of the proposed outfalls.

2d. Levees of sufficient strength and grade to afford absolute protection against floods in the river or lake.

3d. Canals, sufficient in number and dimensions to receive and hold, as reservoirs, a large proportion of the drainage, and to conduct it to the drainage machines.

4th. Drainage machines, of proper number, power and location.

5th. Intercepting canals, to receive the ordinary flow from the gutters during dry periods, and conduct it through Bayou Bienvenue to

Lake Borgne; thus allowing only the surplus water of great rainfalls to be discharged into Lake Pontchartrain.

6th. The rectification of the dimensions and grades of gutter bottoms, bridges, culverts, streets and sidewalks.

7th. The extension of permanent and impervious pavements as rapidly as possible.

8th. The extension of canals, similar to the Camp, Melpomene and Nashville Avenue, to other parts of the City, now insufficiently drained from the existence of local depressions, or the distribution of the fall over excessively long lines of drainage. It might be desirable to execute a part of this work in the order of details Nos. 3 and 5.

9th. The lining of the sides and bottoms of these and all other canals in populous neighborhoods, such as the Camp and Melpomene and part of the Claiborne, with brick, concrete or other permanent material.

10th. Providing means for flushing all canals.

11th. The subsoil or tile drainage of streets and premises.

It is easy to anticipate further improvements to which the execution of this work will lead, but they may be left out of this discussion. Much of what has been detailed, it will be impracticable to undertake at the present time, although it is necessary that the plan should have it in full contemplation as essential to the complete drainage of the City.

But there is certainly no doubt that the five first items are of such supreme and immediate importance that special taxation should be resorted to, if necessary, for their accomplishment. Items Nos. 6 and 7 should also be carried on as steadily and rapidly as is financially practicable.

I therefore beg leave to recur, for fuller consideration, to these special items (Nos. 1, 2, 3, 4, 5, 6 and 7):

1st. A survey. The necessity of this seems too obvious for discussion. It essentially precedes the preparation or adoption of any plan. It should be stated, incidentally, that the want of information, to be obtained only in this way, seriously embarrasses the operations of the Surveyor's office. The sidewalk grades, now daily demanded, require much labor that would be unnecessary if a reliable hypsometric survey were available. It is also important to consider that whenever a better system of drainage is adopted, with the necessary increase of canals, that the lines of drainage in many parts of the City will be shortened and reversed, thus changing grades now given, and leading to expense, dissatisfaction and litigation.

The necessary survey could be made for about ten thousand ($10,000) dollars.

2d. Levees. Any overflow of this City, either from river or lake, is so readily prevented and so disastrous in its effects, that such an occurrence seriously reflect upon its intelligence and enterprise. I have

had the honor, at recent meetings of the Council, to make report on the condition of the several City levees. The recommendations therein were intended to cover the least possible repair work for temporary security. This seemed to me the proper course under the circumstances. But the work recommended in this report is of a much more extensive character, although still entirely essential to the dignity and safety of the City. It is such as should be done under a special tax, to remove for many years all possible danger and expense of maintenance, provided the most ordinary police surveillance is exercised.

The levee of the river front of the Sixth and Seventh Districts, throughout most of its length, should have the crown widened to at least eight feet and the slopes to one to three. All revetments on the river side, as fast as they fall into disrepair, should be replaced with earthen slopes. The grades are generally sufficient, and no new locations are required at present. I estimate the cost of this work at about twenty thousand ($20,000) dollars.

The levee on the river front of the Third District is, throughout most of its length, in precarious condition for so important a work, owing to its location on the immediate edge of the bank. A thorough repair of all revetments, amounting in many places to reconstruction, is probably the most available measure of protection that can be now adopted. The grades are generally sufficient. Some new locations could be made to advantage. I have estimated the cost of this work at about fifty-six thousand ($56,000) dollars.

The levees for protection from lake overflow require a large increase of both grade and section, as their remote location renders them especially liable to depredation and injury. It is advisable to give to the crown sufficient grade and width to fit it for use as a roadway. By adding to their uses as levees the convenience and dimensions of a roadway, they would be less liable to neglect and wanton injury. From their inaccessible position, in many cases, a roadway over which labor and materials could be delivered, in cases of emergency, would add to their security. I estimate the cost of this work at sixty thousand ($60,000) dollars.

3d and 5th. Canals. The canals should serve to receive the drainage from surface and gutters, and conduct it with the least possible resistance and by the most direct routes to the pumping stations. In their present condition these canals have so little reservoir capacity, are so choked with filth, and follow such indirect routes that, on the occasion of any sudden rainfall, they overflow before their waters can reach the drainage machines. Were they all cleaned out to their original dimensions their ability to serve as reservoirs would not exceed the figures given below :

TABLE OF CAPACITIES OF DRAINAGE CANALS.

| | Cubic feet of capacity. | Proportion of 1 inch of rainfall over district. |
|---|---|---|
| First Drainage District, between New and Old Canals | 3,646,550 | 45-100 |
| Second Drainage District, above the New Canal..... | 7,259,368 | 23-100 |
| Third Drainage District, from Old Canal to Lafayette Avenue..... | 5,317,524 | 35-100 |
| Fourth Drainage District, below Lafayette Avenue... | 364,320 | 27-1000 |
| Entire City..... | 16,587,762 | 24-100 |

Besides the cleaning and enlargement of the present canals, others should be dug, until, if possible, their reservoir capacity was equal to an inch of rainfall over their respective districts. The excavation required for this cleaning and excavation would be about 2,250,000 cubic yards, costing, at twenty cents per yard, four hundred and fifty thousand ($450,000) dollars.

It is of extreme importance in the drainage and sanitation of the City that the water surface in these canals should be kept down by pumping to the lowest possible level—six feet below the surface of the soil, and more, if practicable. Heretofore, as is well known, they have frequently stood nearly bankfull, largely from the inefficiency of the pumps. The adjacent lands are, at all times, in a state of such thorough saturation as to be unable to absorb and retain any important proportion of the rainfalls, which are therefore precipitated in bulk into the overcharged and obstructed canals. Much importance is due to this recommendation, for the following reasons: The execution of this part of the system will be equivalent to raising the ground by filling to a height equal to the depth to which the water surface may be depressed. When this is done, the adjacent lands will become dry and porous. Beyond the immense sanitary and agricultural benefits of this change, the soil will then be in a condition to absorb and retain a large proportion of the rainfall, allowing a greatly reduced quantity to flow from the surface to add to the overflow of the canals and the labors of the pumps. There can be no doubt of the economic importance of this practice in largely reducing the aggregate volume of water to be pumped. The improvement in sanitation, in the condition of the roads, and in the products of farms and gardens, will be equally marked and important. Results truly comparable with those of raising the surface several feet will thus be secured at a relatively insignificant cost.

It is also evident that whatever permanent depression is given to the water surface in the canals will be added to the insufficient grades of the gutters and sub-drains in many parts of the City. There are at present to be found gutters with a fall of less than one foot in a thousand. This difficulty rapidly increases as the City is extended back from the river. In consequence, unless a rainfall intervenes, the sewage entering the gutters remains, passing through all stages of decomposition. When the number of canals is increased and the distance to an outfall thus diminished, sufficient grades can be obtained to effectively drain all streets and premises.

It should also be remembered that, if the canals are kept in the condition here proposed, the cost of maintenance would be much reduced. Deposits would not accumulate so rapidly. The banks would acquire firmness, and, as they became more and more tied together by the roots of grasses and other vegetation and covered with a sod, would be less subject to sloughing.

These incidental benefits seem sufficient to approve the recommendation. But the provision of ever-ready reservoirs to receive and hold the drainage from a considerable rainfall, until the slopes and velocities necessary to deliver it to the pumps are established, is an essential feature of good drainage.

In extending the present canal system, it will probably be necessary at first, for reasons of economy, to give a considerable degree of independence to the sub-system of each drainage district. But it is important that this present and partial work should be done with the view of the ultimate connection of the several districts into one, under one system, as an essential part of a good and complete plan. While, from financial inability to complete a general system, it is probable that, for some time, the canals in each district will only serve to conduct the drainage to the district pumping station, from which it will be discharged into Lake Pontchartrain; yet all new canals should be located with reference to their ultimate division into two classes. The first of these will consist of one or more canals along and parallel to the lowest levels of the valley between the river bank and the ridges, extending from the upper parts of the City through all the districts, and uniting in a main trunk drain leading to a pumping station at the head of Bayou Bienvenue. This machine will be in constant operation to effect the removal to a point remote from the City of the ordinary dry weather discharge from the gutters and drains at a time when it is most noxious and offensive from want of dilution. It will also pump and keep down the level of the water throughout the entire network of canals to such a point as is necessary to maintain them as reservoirs for heavy rainfalls, to desiccate the soil, and to secure the other benefits that may reasonably be expected from the system.

An incidental benefit of this part of the plan is the reclamation and preservation of Lake Pontchartrain in fit condition for pleasure and business purposes, by the removal of the larger and more offensive part of the discharge from the City to a point so remote and so open to the tidal movements of the Gulf, that it can offend no community or interest.

To the other class of canals will be relegated the duty of removing rainfalls whose volume exceeds the capacity of the main trunk just described. Therefore the operation of the machines to which they lead will not be constant. Their discharge into Lake Pontchartrain will consist only of such large volumes of rainwater that the sewage contained, will be diluted to an extent that will abate, if not entirely destroy, its noxious properties.

4th. Drainage Machines. Our present drainage plant is defective in design, capacity and location. The foundations, machinery and buildings are now in dangerously bad order. But in their best estate they would be totally inadequate to pump, within a reasonable time, the drainage from the surface after heavy rainfalls, or to sufficiently lower the water level in the canals or the saturation level in the soil. They are of antiquated design and construction, and lacking in modern devices to economize power and fuel.

In designing a new system of drainage it is essential that the volume of water to be dealt with in each district should be accurately known. The rainfall, per unit of surface, is practically the same throughout the area of the City, but the proportion to be drained therefrom varies largely in the different districts, with the grades, the relative extent of building, cultivation, paving, ditching, and other conditions. To determine this with accuracy requires a survey. The removal of the entire surface drainage of a city by pumping is very exceptional, there being no other instance in this country in which it is necessary. Hence, but few observations bearing on the subject have been made or recorded. The importance of a careful study in this case is, therefore, apparent.

The following table is submitted, for the time, based on the assumption that rainfalls of six inches are of sufficient frequency to make it necessary to provide for the removal, within twenty-four hours, of such part as is not retained by cisterns, absorbed by the soil, or consumed by vegetation :

TABLE OF THE PROPORTION OF SIX INCHES OF RAINFALL, TO BE PUMPED FROM EACH DRAINAGE DISTRICT IN TWENTY-FOUR HOURS.

| DRAINAGE DISTRICTS. | Total area, acres. | Total volume of 6-inch rainfall, cubic feet. | Area of imp'd lands, acres. | Area of unimproved lands, acres. | Proportion of Drainage from imp'd lands, per cent. | Proportion of Drainage from unimp'd lands. | Volume of Drainage from improved lands cubic feet. | Volume of Drainage from Unimproved lands, cubic ft. | Total volume of Drainage, cubic feet. |
|---|---|---|---|---|---|---|---|---|---|
| First District, between New and Old Canals..... | 2,218 | 48,308,040 | 1,530 | 688 | .75 | .30 | 24,992,550 | 4,495,392 | 29,487,942 |
| Second District, above New Canal... | 8,650 | 188,397,000 | 4,630 | 4,020 | .50 | .25 | 50,420,700 | 21,888,900 | 72,309,600 |
| Third District, from Old Canal to Lafayette Avenue..... | 4,612 | 100,449,360 | 1,820 | 2,792 | .60 | .30 | 23,785,760 | 18,242,928 | 42,026,688 |
| Fourth. District, below Lafayette Avenue..... | 3,724 | 81,108,720 | 1,247 | 2,477 | .50 | .25 | 13,579,830 | 13,487,265 | 27,067,095 |
| Entire City..... | 19,204 | 418,263,120 | 9,227 | 9,977 | .56 | .27 | 112,776,840 | 58,114,485 | 170,891,325 |

Assuming the mean or average lift from the interior canals to the level of the lake as three feet, there would be required for the removal of this volume of storm drainage an aggregate of six hundred and seventy-four horse power. This would be divided between the different districts as follows: First District, 116 horse power; Second District, 285 horse power; Third District, 166 horse power; Fourth District, 107 horse power. This power could be concentrated to advantage in one pumping station for each district, except the Second, where, owing to the large volume and area, it would be advantageously divided. In that District the Melpomene station should be moved back to the junction of the Melpomene and Toledano canals. A better location could also be found for the other than that of the present Dublin avenue station. In the First District the pumping station could be advantageously moved forward to Broad street, bringing it nearer the centre of the highly improved section which it serves. and also on the probable line of the trunk drain, through all the Districts to Bayou Bienvenu.

The London avenue machine is well located, particularly with reference to the ultimate erection in the lower part of the Fourth Drainage District of the station for general service already described. This machine is also of better construction and in better order than any of the others, and with thorough repair could be made serviceable for several years.

Regarding the kind of pumping machinery to be used, it does not seem important to go into much discussion at the present time. The ordinary wheels, generally used in this part of the country, have the advantages of extreme simplicity of construction and operation, and of a high duty under certain fixed conditions. On the other hand, they require heavy foundations, and do not adjust themselves readily to differences of lift. Their useful effect rapidly diminishes, both as the level of the inner water falls, or as the lift is reduced, while a large proportion of power is consumed in revolving a ponderous wheel at a constant rate while the volume discharged may be a minimum. Centrifugal pumps, on the other hand, adapt themselves readily to the changes in the lift, or in the levels of the interior and exterior waters. With both inlet and outlet properly submerged, the useful effect should be proportionate to the lift, for the syphon action overcomes any intermediate elevation. They are, however, more liable to injury and more difficult to repair than wheels.

The opinion of the Hollanders is valuable from their large experience with such enterprises. This runs steadily in favor of centrifugals. The following table shows the number of pumping machines, of different types, erected in Holland from 1875 to 1881:

| | 1875 | 1876 | 1877 | 1878 | 1879 | 1880 | 1881 | Total |
|---|---|---|---|---|---|---|---|---|
| Wheels | 3 | 1 | 1 | 4 | 12 | 9 | 8 | 38 |
| Centrifugals | 1 | 1 | 6 | 6 | 11 | 9 | 16 | 50 |
| Wheels and Centrifugals combined | .... | .... | .... | 1 | .... | 1 | 1 | 3 |
| Wheel pumps | .... | .... | .... | 1 | .... | 1 | .... | 2 |
| Screws | 3 | 1 | 7 | 2 | 12 | 4 | 1 | 30 |
| Piston pumps | .... | .... | 1 | 1 | .... | .... | 2 | 4 |
| Various | 3 | .... | 2 | 6 | .... | 1 | .... | 12 |
| Total | | | | | | | | 139 |

None of the machines mentioned in this table, other than wheels and centrifugals, have any special advantages in connection with this work. In reaching final conclusions on this subject, it should be observed that in Holland the greatest differences in level are in the external waters, caused by the tides of the German Ocean, while here they would be greatest in the internal waters.

It seems probable that, for those pumping stations which are intended to discharge the surplus of heavy rainfalls directly to Lake Pontchartrain, that wheels would be most satisfactory. For the station intended to remove the ordinary and constant discharge from the City to Lake Borgne, and to hold the level of the canals, at such times, many feet below the surface, and for working against the greater and more variable heads which these conditions involve, there is little doubt that centrifugals would prove to be the most efficient.

The recorded experience in the erection of large public pumping stations, in this and other countries, indicates their cost at from four to five hundred dollars per actual horse power, including foundations, machinery and buildings complete. At the smaller of these figures, pumps of the required capacity, for the independent work of the four Districts, would cost about two hundred and sixty-five thousand six hundred dollars. To this estimate for machines to deal with the surplus water of great rain storms, should be added one hundred thousand dollars for the pumping station at Bayou Bienvenu, and the necessary auxiliary works.

The details thus far described, viz: a survey, preceding and directing intelligently all work, levees, canals and drainage machines, are the foundations of all future progress. It is essential to our survival as a centre of civilization and industry that at least this much should be thoroughly and immediately accomplished. I have estimated the cost of these works as follows:

| | |
|---|---|
| First. A survey | $ 10,000 00 |
| Second. Levees | 136,000 00 |
| Third. Canals | 450,000 00 |
| Fourth. Drainage machines | 365,600 00 |
| | $961,600 00 |

To this estimate can, of course, be attached only the value of a rough approximation. It would manifestly be misleading to pretend to greater accuracy until a survey and full subsequent study had made possible the design of the details of the system.

It is entirely practicable to commence all of this work at the same time, and carry it forward at the same rate of progress in each of the four Drainage Districts. Under the necessary financial arrangements the work could be commenced immediately and completed and put in operation within two years throughout the entire City. There is no reason, inherent in the plan itself, why any section should have any priority in the inauguration of the work, or in the enjoyment of its results. The time required for the collection of the necessary funds, whether from special taxation or otherwise, will take more time than is required for the execution of the work. While a tax might, and probably would be, extended over several years, to make it less onerous, it is highly important that we should not wait that time for the relief that can be readily secured in two years. To prolong the building of levees, the cleaning and excavation of canals, and the erection of pumping stations over ten years is neither conducive to economy or good work. Each of these is a *specific* work, which would be best and most cheaply done, when promptly done.

It would, therefore, be of extreme importance that the commission, or other organization to which the administration and execution of these works are entrusted, should have the authority to establish a credit, either by the issue of bonds, or the right to contract against the ultimate proceeds of the tax, or by other similar means that it seems best to adopt, in order that, if the citizens of any drainage district, or any part of them, desire to realize the results and benefits of the system within the time over which the tax extends, they may have the opportunity of advancing the funds necessary for the execution of that part of the general system in which they are locally interested, and be secured by the Commission in the return of any such advances as fast as the tax is collected.

Of hardly less importance than the work heretofore described, as the foundation work of a system, is that comprised in items Nos. 6 and 7, viz: the rectification of the grades of gutters and drains, and the extension of pavements.

6th. Undue importance is now attached to the grading up of sidewalks, as a means of ridding the City of overflow from rains. A little experience with the street and gutter grades makes it quite evident that,

in a large number of cases, adequate relief could be obtained by the systematic rectification, enlargement and lining of the guttres and culverts at the intersection of streets. Occasionally a block is found with an up grade in the direction in which it is intended that the water should flow. Blocks are frequent with no fall in either direction; while, almost everywhere, the existing fall is insufficient to cause a self-cleansing velocity. In fact, the work has been done without a system, or, in other words, without a survey. This work of properly grading and building the gutters and culverts can be done, under any ordinary conditions, at a much less rate, per linear foot, than the cost of raising a sidewalk. The practical difficulty in the way is that, while each front proprietor may raise his own sidewalk above overflow, the obstruction which causes or increases this overflow is often at some distance from his property. Such work must, therefore, be done by joint and compulsory action, that is, by the City.

This method of facilitating the discharge of surface drainage has the further advantage of not ponding up the rainfalls in the yards of premises, as is now done in many cases, with the worst sanitary results, by the indiscriminate raising of sidewalks. The crude and arbitrary terms of the ordinances on this subject will continue to work harm rather than good, unless they include provisions for the proper filling of lots, and for improved drains in the yards and under the sidewalks, where the latter are raised.

But when an improved and enlarged system of canals is adopted, and pumping power is provided for maintaining a low level of water in these canals, this work of regrading can be undertaken and vigorously pushed with great advantage. Many lines of drainage would then be reversed, while all would be of less length and greater fall.

7th. Of course, continued work in the paving of streets is always in order. It should commence with the earliest work of improvement and be persistently pushed, as a sanitary, commercial and social measure, as fast as funds can be provided. Discretion should be showed in a preference for pavements that are permanent and impervious to water from above and the exhalations of soil gases from below. The wisest economy in a pavement is not generally in its first cost. Wherever practicable, contracts for new pavements should contain a clause for maintenance extending over a term of years.

In brief, the plan which I have endeavored to present, with such sharpness of definition as the want of the exact information to be obtained only by a survey will admit, may be thus stated. The levees around the City, both front and rear, should be made safe so that no waters would ever be found within its limits, except from rainfall and sewage. For the reception of these large and accessible canals should be provided, and kept so pumped down as to afford sufficient reservoir capacity for all emergencies that recur with sufficient frequency to make their prevention

of importance. These canals and their pumps should be connected throughout the entire drainage area, but so divided in their functions, in the several drainage districts, that some would be specially adapted to act in the emergency of removing the surplus water of great rain storms to the nearest outfall in Lake Pontchartrain; while the others would require constant operation in maintaining the entire system, at all times, in a condition to serve as reservoirs, and in removing the foul discharge of premises and streets, during ordinary times, to a more distant outfall. During the execution of this work, the rectification of gutters and culverts, and the extension of pavements should be in steady progress. The canals in populous parts of the City, the Camp, Melpomene, Galvez, Claiborne and others, should be reclaimed from their indecent condition by linings of brick or concrete. Similar canals should be extended to other central parts of the City, where the drainage is now defective. Means for flushing all these canals and the gutters with river water should be provided. The lowering of the water surface in the canals would provide the necessary outfall for the effective introduction of tile or subsoil drainage under streets and in private premises, with important economic and sanitary results.

It may be that all of this cannot be accomplished by this administration, or, perhaps, by this generation; but, at least, it can be so worthily and intelligently commenced that we may enjoy a large measure of its benificent results, and justly claim to have laid the foundations of the health and prosperity that will surely follow it.

In conclusion, it should be stated that this report is only applicable to the municipal districts on the left bank of the river. In Algiers, the drainage problem is comparatively simple. The inclination of the surface throughout the area occupied, is generally quite sufficient to insure good drainage by the judicious employment of gutters, canals and pumps. If the taxes of the Fifth District were devoted to exclusive use within its own limits, they would suffice for its drainage and such other advantages as it actually receives from incorporation with the City.

In the protection of the Fifth District against river overflow, however, great difficulties exist, with which the City is in no way prepared to contend. From the Morgan's Louisiana and Texas Railroad depot to the lower end of the corporate limits, a distance of twelve miles, the entire line of levees is in unsafe condition. Considerations of the true interests and safety of that section should supercede the motives which led to its incorporation with the City, and should restore all of it below the urban part of the District to the economy of a parochial government, and the protection of the State levee system.

Neither does this report include any recommendations concerning the lands between the ridges and Lake Pontchartrain. The importance to the

City of including this tract in any general system of improvement and sanitation is so evident that nothing but financial exigencies would justify its omission or postponement. It should be leveed, cleared and drained; and its surface exposed to the beneficient influences of the sun and air. The sanitary benefits of this would extend over the City, while the local economic and agricultural results could be made to pay for this part of the improvement.

Very respectfully,

B. M. HARROD,

City Surveyor,

New Orleans, November 22d, 1888.

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